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Bt-Transgenic Plants: Resistance Management Strategies

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B*acillus thuringiensis (Bt)*, a common bacterium, is revolutionizing agriculture as the basis of a strategy to protect plants from insect attack. Incorporated into plants through genetic engineering, the bacterium's DNA produces proteins that create resistance to pests, with little or no harm to the pests' natural enemies — thereby allowing the enemies to continue to suppress the pest population.

The potential benefits of the technology to agriculture, farmworkers, and the environment are tremendous in light of the financial, human, and environmental costs of many chemical methods of pest control. Researchers are finding, for example, that *Bt* cotton requires three or fewer insecticide treatments per year, compared with traditional averages of 5 – 12 insecticide applications annually for U.S. cotton crops.

Joe Ogrodnik

The adult diamondback moth is the only agricultural pest that has developed resistance to *Bt* in the field.

Resistance Management

Despite the potential benefits of *Bt* technology, there is widespread concern that these gains will be short-lived due to the evolution of resistance to *Bt* in pest populations. With support from the National Research Initiative (NRI) Competitive Grants Program, researchers at Cornell University are testing resistance management strategies for *Bt*-transgenic plants. The scientists have created a model system using the diamondback moth (DBM) — the only insect that has developed *Bt* resistance in the field (see illustration) — and broccoli plants created to express various *Bt* toxins.

Maintaining Susceptibility

The researchers have explored ways to conserve susceptible DBM genes while simultaneously allowing *Bt*-transformed crops to control the pest species (see illustration on reverse page). In greenhouse and field settings, the scientists have conducted a series of tests to exam-

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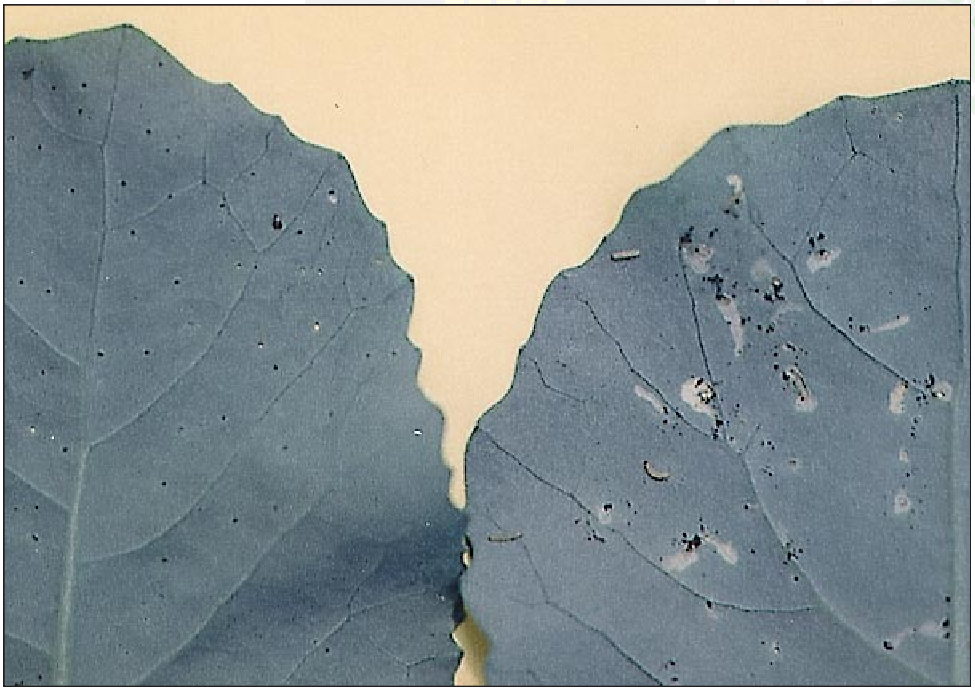
ine the effects of various management strategies, including the proportional abundance and placement of *Bt*-expressing plants, on the development of *Bt* resistance in the insect population.

The researchers have demonstrated that a separate refuge, in which *Bt*-transformed plants are separated by some distance from non-*Bt*-transformed plants, provides better results than a mixed refuge in which *Bt* and non-*Bt* plants are grown together randomly in the field. They also have observed that larger refuge sizes are associated with delays in the onset of pest resistance. If no resistance strategy is employed, resistance and consequent loss of pest control may appear within fewer than five DBM generations.

Other Strategies

The scientists also have demonstrated that the common practice of spraying refuges with a non-*Bt* chemical may reduce the population of susceptible insects below the level needed to maintain susceptibility in the population as a whole. This finding has led to consideration of other strategies, such as use of different toxins at different times or in different places.

Historically, insects have proven their ability to overcome many of the pest control strategies devised by humans. However, research is suggesting ways to delay resistance development and to stay ahead of the resistance cycle through the application of current pest management techniques and the development of new ones. ❖



Diamondback moth larvae feeding on a broccoli leaf expressing a *Bt* toxin (left) and on a non-*Bt* broccoli leaf (right).

Juliet Tang

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